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ABSTRACT

Visual demonstrations may be used as part of programs to deliver both content objectives and process objectives. Research has shown that learning of concepts is easier, more accurate, and more broadly applied when it is accompanied by visual examples. The visual examples supporting content learning should emphasize both discrimination and generalization skills. However, when procedural objectives are being taught, visual examples should emphasize the discrimination of appropriate parts and procedures and the chaining of responses. Discrimination in concept learning involves a decision as to whether a given situation belongs to a certain class of events, whereas discrimination in procedural learning involves identification skills. These distinctions imply differences in the format of visual demonstration used to support different learning objectives. In both cases, the presentation should guarantee that subjects attend and observe and that subject responses are contingent upon the observations that have been made. (EMH)

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TECHNIQUES FOR PROGRAMMING VISUAL DEMONSTRATIONS*

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Non-textual programming may be designed for textual or for non-textual purposes. Visual demonstrations may be programmed for such "textual" goals as the teaching of verbal concepts and principles. They may be programmed for such "non-textual" goals as the teaching of procedural/motor skills. With the goals and their related criterion behaviors being quite obviously different, the programming techniques to achieve them will differ. Contrasting the techniques can serve as a useful illustration of the process of formulating and implementing instructional strategies.

A convenient way to start might be to present some findings from an experiment on procedural learning performed just a couple of weeks ago. With seventh graders as the target population, a television tape was prepared demonstrating the assembly of a three-pole electrical motor. One variable investigated was the length of the demonstration unit preceding the opportunity for student practice. A second variable investigated was the type of practice allowed following the demonstration. One group of students practiced the actual assembly of a motor after watching the demonstration. A second group working with illustrations in practice booklets received practice in distinguishing correct from incorrect assemblies. Both groups assembled a motor as a criterion performance. On the criterion task, preliminary results indicate the superiority of actual practice over recognition or discrimination practice. Although nearly all Ss in both groups assembled motors that ran (with varying degrees of help), the actual-practice group made nearly half as many errors along the way. This may mean that for certain types of learning tasks, for example tasks in which new responses are to be learned, actual practice is superior to recognition practice.

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These data were reported to throw some light on the more general problem of selecting an instructional strategy for given instructional objectives. In the case of concept learning and in the case of procedural learning, what learning opportunities must visual demonstrations provide? The answer to that question will determine the shape and form the programming of demonstrations will take.

Consider learning of concepts and principles from visual demonstrations, first. As in all such learning, the student must have the opportunity to acquire within class generalizations and between class discriminations. Suppose the student is to learn the principle in the use of levers that the closer the fulcrum is to the load the less applied force will be required. If the student is to acquire this principle on the basis of visual demonstrations, he must have the opportunity to observe more than one instance of a closer fulcrum position and also the opportunity to distinguish the results of a closer and more distant fulcrum position. Visual demonstrations used must provide these opportunities. These learning opportunities could, it is true, be presented by means of verbal examples. Recent studies by Gropper (1966), provide empirical support for the often asserted view that concrete examples make learning easier. In these studies it was found that: (1) learning was easier when based on visual examples than when based on verbal examples; (2) learning of concepts from technical verbal materials was easier when it followed a visual lesson on the same concepts; and (3) learning from visual (rather than verbal) materials results in broader transfer in a subsequent testing situation. In view of such findings, one might argue for the use of visual examples as a first step in the teaching of concepts and principles. The technical verbal language can be easily mastered when it follows. In these studies, the serial intermixing of visual and verbal lesson segments provide a prototype for the effective integration of single concept films and self-paced programs or for the integration of visual and verbal materials within a lesson entirely on film or TV tape.

What were the visual demonstrations like that facilitated concept and principle learning? I would like to use these blocks (which I used at the most recent NAEB meetings) to illustrate the use of visual examples to teach the relationships between "force" and "pressure." An oblong piece of wood is

laid along its long side on a taut sheet of paper. The paper supports it. This situation is contrasted with (distinguished from) the tearing of paper when the same oblong is placed on its end on the same piece of paper. This demonstration makes possible the discrimination between the consequences of a large area and a small area (belonging to the same object) coming in contact with the taut piece of paper. Another oblong of different size is used in similar fashion, but this time students are expected to predict the differential consequences of different areas coming in contact with a taut sheet of paper. A trapezoidal object is similarly used (generalization). A cube is used to make the discrimination that it is area and not position that makes the difference. On the basis of this type of concrete practice, the principle is acquired that paper tears when the smaller area (of a given object) comes into contact with a taut piece of paper. The subsequent verbal program on the relationship between distribution of force and pressure although couched in technical language is readily learned. Having already acquired the principle, it is less difficult to master the technical language expressing it.

The instructional strategy here involved considerations of the acquisition of the discriminations and generalizations underlying force/pressure relationships. They also involved considerations of mode of stimulus presentation (visual vs. verbal) as a means of facilitating learning. Response options used were pictorial (a mode consideration) and the decision to do so was also made in terms of instructional strategies (response options result in easier learning of subsequent verbal materials when they are pictorial rather than verbal). Strategies thus concern not only conditions that provide opportunities for appropriate discriminations and generalizations to be acquired. They may also concern mode of stimulus presentation and mode of response. They may also concern the joint use of and sequencing of alternate modes.

What must a strategy be like for teaching procedural skills? What must an instructional strategy be like for teaching the assembly of a three-pole electrical motor? Unlike concept learning which is concerned with classes of events and the attributes that qualify for class inclusion or class exclusion, learning to put a particular motor together (as opposed to a variety of motor types) is concerned with unique events and objects. Generalization is not a concern here. Discrimination learning is relevant but it is not concerned

with class inclusion or exclusion. It is concerned with identification and selection of particular parts, the particular location in which they are to be assembled, and what the particular assembly looks like when completed. Discriminations are between right and wrong parts, between right and wrong locations, and correct or incorrect assemblies. Procedural skills also involve long chained responses. Visual demonstrations must provide the opportunity to learn the discriminations and to acquire and retain the long chains. Demonstrations can serve as a model (a cue) which the student imitates. The primary problem in strategy formulation is concerned with the length of the demonstration segment and the resulting delay before practice is possible. Strategies for procedural learning in addition to being concerned with long sequences of operations may also concern opportunities for discrimination practice (e.g., recognition or editing) of correct part selection and assembly.

The actual sequence of procedures in assembling the three-pole electrical motor was demonstrated for students. Students were expected to follow the same sequences. In addition to copying the model performance, they were given the opportunity to practice selecting the correct parts (having had the parts identified earlier). They were also given the opportunity for practicing identifying correct or incorrect assemblies.

Summary

The essential differences between demonstrations designed to teach concepts and demonstrations designed to teach procedural skills were as follows:

(1) to permit the acquisition of a generalized response to classes of events (in concept learning) a variety of examples were used.

(2) to permit the unique chaining of responses (the assembly of a particular motor), an example was offered (or even the repetition of the same example) which students could copy.

(3) discriminations in concept and principle learning had to do with inclusion of an event within a class of events or its exclusion, or with the relationships among events.

(4) discriminations in procedural learning had to do with the identification of particular parts and with the correctness or incorrectness of their assembly.

Given these differences in derived behavioral outcomes, the demonstrations were obviously programmed differently. In addition to differences in the design of stimulus conditions required by strategy differences, response requirements were obviously different. For learning of principles, students were required during learning to make predictions about new demonstration outcomes or to indicate what antecedents would be necessary for a given outcome. For learning of procedures, students were required during learning either to produce a particular chain of responses or to select from illustrations a correct instance of an assembled section of the motor.

Other applied technology problems are common to both types of programming endeavors. Both must see to it that responses are brought under the control of the visual presentation. As in verbal programming, this means that active responding is required. But, as in verbal programs considerable prior behavior may occur before responding is required. In verbal programs, various amounts of reading behavior are required before the student fills in a blank or selects a correct answer from options offered him. In visual programs, students may merely watch fairly lengthy demonstrations before they are required to make a response. In the case of verbal programs, we needn't be too concerned about the lack of systematic control over the student's reading behavior. If as Holland has suggested the active response is truly contingent on the prior, or as he puts it, precursory reading behavior, and if students are capable of producing the correct response, we may be content that the appropriate reading behavior has indeed occurred. Similarly, in the case of visual presentations, if correct responses are made and the responses are truly contingent on prior attending and/or observing behaviors, we may be satisfied that the attending and/or observing behaviors have been made. While it is not particularly difficult to manipulate the contingent nature of the relationship between active

responses and precursory behavior, the problem arises of how to insure that a correct response will be made. In verbal programs, frames are generally short and the probability of appropriate reading behavior being made is quite high. In visual demonstrations, demonstration units are likely to be of longer duration. Competition among visual stimuli can occur. One of the problems, thus, in designing the visual stimulus is of focusing on the relevant dimensions to be discriminated and of reducing and excluding other dimensions. A second problem concerns the length of the demonstration unit to which Ss will attend and on the basis of which they can respond correctly. While visual demonstrations for whatever purpose are likely to be longer than a verbal frame -- and hence a weaker cue -- there may be differences in this regard as between demonstrations for teaching concepts and for teaching procedural skills. For concept purposes, visual segments are apt to be shorter and responses required more frequently. This is likely to be so because we wish to make learning of concepts easier. On the other hand, to make demonstrations more efficient for procedural learning, we are more likely to want to make them as long as possible before response practice is required. It also seems likely that attention to and observation of details may be more important for procedural learning than for learning of concepts.

In both cases, however, the presentation must be prepared in such a way as to guarantee that attending and observing behaviors will be made and that active responses are contingent on such prior behavior. When correct behaviors are then made, we have evidence that we have indeed controlled student behavior during a visual presentation. Such evidence should come at strategic points in the presentation and not merely at the tail end. Performance at the tail end may be insufficiently diagnostic of where a presentation went wrong. The feature that characterizes this problem as it affects visual presentations, as opposed to verbal ones, is the generally greater length of the visual presentation before response practice is required.

On the practical level, what are some of the techniques involved in programming visual demonstrations?

A. Visual presentations can contain a single stimulus and/or a complex pattern of stimuli. To insure that Ss attend to relevant dimensions of stimuli or to particular stimuli among other stimuli, the following pointing techniques are available:

(1) by selecting what to include or exclude from the visual frame, we can control what the viewer attends to. For example, if we wish him to attend to the fact that the brushes of a motor touch the commutator, we can frame only the end of the motor containing the brushes and exclude the rest of the motor.

(2) or if the entire motor is shown, we can physically point to the motor; or by means of pop-ons or animation or special lighting, call attention to it.

(3) or we can use words alone or in conjunction with the above techniques to accomplish the same thing.

B. For teaching discriminations, split-screen techniques are available to contrast two stimuli simultaneously. Or successive frames may be used to present similar contrasts. Static contrasts within a given frame or across a split screen are probably best reserved for static visuals (e.g., how the same object might look under two different conditions; or which of two presentations is correct); successive frames might best be reserved for presentation of action scenes (e.g., how the wires are wrapped around the pole of a motor). Action contrasts on a split screen might provide too much competition for the viewer's attention. Thus, simultaneous contrasts as well as successive contrasts are available for discrimination practice.

Response options to be used for discrimination practice can be presented in much the same fashion. Results of studies I have done on concept learning suggest that pictorial response options make the subsequent learning of verbal materials easier than is the case when verbal options (to pictorial presentations) are used.

C. How words and visuals are to be integrated within a demonstration can be particularly crucial in influencing the cue value of presentations. When demonstration lags too far behind a verbal description of an event or vice versa, cue value will be reduced. If demonstration precedes verbal

description by too long an interval, attention may be drawn to an irrelevant dimension. If words come too soon, there may be a failure to associate the word with the proper physical dimension of an object (particularly when technical names are used). There is to be sure evidence suggesting the value of previous familiarization with parts to be assembled in procedural learning. As a general rule, simultaneous verbal and visual presentation seems to have the best cue value. In my experience, however, this is not always the case. Sometimes, and about this I don't have any rules to offer, one should precede the other. What the rules are for showing words before pictures in some cases, and the converse in others, I can't say. All I can say is that in either case, the lag should not be more than a few seconds.

D. My impression is, and it is not based on research evidence, that the requirement of the subjective camera angle applies to those procedural/motor skills in which the emphasis is on the motor part (e.g., tying knots). Where the emphasis is on the selection of parts, on where they go, and the sequence in which they are assembled, other camera angles are possible. For example, we may wish to provide discrimination practice concerning the look of correctly wrapped wires in the electrical motor (e.g., evenly spaced and across the whole pole). For this purpose, the opposite view from the one we would have while wrapping the wires might serve better for this purpose (e.g., give a more unobstructed view).

E. When using models instead of actual objects, it appears important to shift back to the look of the real object. Ss will be expected to have to be able to make appropriate discriminations about what the real object looks like when correctly assembled and differences between real objects and models for them in size, color, materials, etc., may make such transfer difficult.

As a final point, the suggestion is made that audiovisual researchers keep logs about their programming problems and procedures. Even in the absence of research evidence on the techniques they devise, considerable practical help can be offered others. Not least of the benefits is the opening up of research issues that merit further exploration.

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